



Tripura University

(A Central University)

Suryamaninagar

West Tripura, Tripura – 799022

Syllabus for
Four Year Under Graduate Programme

Subject: Zoology

(NEP – 2020)

Year – 2023

**DETAILED COURSE CONTENT OF
ZOOLOGY (MAJOR)
(SEMESTER – 1ST - SEMESTER – 5TH)**

1st Year
Semester-I
Paper 1: NON-CHORDATES
Paper Code: ZL101C
Total Marks: 100 (IA = 40 + ESE = 60) Credit = 04

(Credits – 04)

Unit - I

Contribution of National Scientists in Zoology

Salim Ali, Vishwa Gopal Jhingran, Hiralal Chaudhuri, Gopal Ch Bhattacharya, Ramdeo Mishra, Hargobind Khorana, Lalji Singh, Radha D Kale, M K Chandra Sekheran, C. R. Narayan Rao, M. C. Dash, Valmiki Thapar.

Phylum - Protozoa

- General Characteristics and classification of sub-kingdom Protozoa upto Phylum.
- Locomotion in *Amoeba*
- Reproduction in *Paramecium*

Phylum - Parazoa

- General characteristics and classification of Porifera upto classes
- Histology & body wall of *Sycon*
- Canal system of *Sycon*

Unit – II

Phylum - Metazoa

- General characteristics and classification of Cnidaria upto classes
- Trimorphism & metagenesis of *Obelia*

Phylum - Platyhelminthes

- General characteristics and classification upto classes
- Life cycle of *Fasciola hepatica*

Phylum - Nematelminthes

- General characteristics and classification upto classes
- Life cycle of *Ascaris*

Unit – III

Phylum - Annelida

- General characteristics and classification upto classes
- Digestive & excretory system of Earthworm

Phylum - Arthropoda

- General characteristics and classification upto classes
- Digestive system of *Periplaneta*
- Circulation in *Periplaneta*

Unit – IV

Phylum - Mollusca

- General characteristics and classification upto classes
- Respiratory system in *Pila*
- Nervous system in *Pila*

Phylum - Echinodermata

- General characteristics and classification upto classes
- Water vascular system in *Asterias*
- Basic larval form and evolutionary significance

Phylum - Hemichordata

- General characteristics of Hemichordata

Paper 2A: Economic Zoology**Paper Code: ZL102C****Total Marks: 60 (IA = 24 + ESE = 36) Credit = 02****Unit – I****Vermiculture & Vermicomposting**

- Principle of vermicomposting, different ecological categories of earthworm (Epigeic, Endogeic, Anecic), importance of vermicomposting, vermitechnology & management.

Unit – II**Sericulture**

- Principle, different types of silk moth and their host plants, rearing methods, diseases of silk moth. Management with special reference to local varieties

Apiculture

- Principle, different types of honey bees, rearing methods, diseases of honey bees. Management with special reference to local varieties

Unit – III**Fresh water pisciculture**

- Polyculture
- Induced breeding technology
- Fish seed transportation, fish diseases,
- Management

Unit - IV**Poultry**

- Types of breeds
- Methods of rearing
- Diseases and their management

Dairy Farming

- Basics of Dairy farming and management.

Paper 2B: Practical (I)**Paper Code: ZL102C****Total Marks: 40 (IA = 16 + ESE = 24) Credit = 02**

1. Identification with reasons
Paramoecium, Scypha, Obelia, Physalia, Fasciola, Taenia, Ascaris, Metaphire, Hirudinaria, Periplaneta, Limulus, Mite, Pila, Lamellidens, Octopus, Asterias, Balanoglossus.
2. Dissection and display of digestive, reproductive and nervous systems of *Periplaneta*.
3. Mouth parts of *Periplaneta*.
4. Spot identification and economic importance of— *Perionyx, Apis* sp, *Bombyx*, and Carps.
5. Identification of diseases with reasons from the photographs provided of the faunal group.
 - silk moth, fish, poultry.

Semester-II
Paper 3: CHORDATES
Paper Code: ZL201C
Total Marks: 100 (IA = 40 + ESE = 60) Credit = 04

Unit – I

Protochordata

- General characteristics of Cephalochordata with special reference to the ciliary mode of feeding in *Branchiostoma/Amphioxus*.
- General characteristics of Urochordata with special reference to retrogressive metamorphosis in *Ascidia*

Unit – II

Cyclostomata

- General characteristics of Cyclostomata
- Differences between *Petromyzon* and *Myxine*

Pisces

- General Characteristics of Chondrichthyes & Osteichthyes
- Accessory respiratory organs in fishes

Unit – III

Amphibia

- General characteristics and classification upto order
- Parental care in Amphibia
- Neoteny & Paedogenesis in Amphibia

Reptilia

- General characteristics and classification upto order
- Heart of Crocodile
- Differences between venomous and non-venomous snakes
- Biting mechanism of snake

Unit – IV

Aves

- General characteristics and classification upto order
- Double mode of respiration

Mammals

- General characteristics and classification upto order
- Comparative account of heart and aortic arch of mammal with those of bird, reptile, amphibian and fish
- Digestive system of ruminant and non-ruminant

Paper 4A: CELL BIOLOGY

Paper Code: ZL202C

Total Marks: 60 (IA = 24 + ESE = 36) Credit = 02

Unit – I

Cell

- The basic concept of Cell (Prokaryotic and Eukaryotic)
- Cell- Cell theory, cell size, the shape of cells, and types of cells
- Structure and function of prokaryotic cell
- Structure and function of eukaryotic cell – special reference to animal and plant cell
- Differences between animal and plant cells

Unit - II

Structure and function of-

- Plasma membrane
- Nucleus
- Mitochondria
- Golgi bodies
- Ribosomes
- Endoplasmic reticulum
- Lysosomes
- Chromosome
- Nucleic acid

Unit – III

- Cell cycle and regulations
- Cell divisions – Mitosis and Meiosis

Unit - IV

Cancer Biology

- Tumor and its type, characteristics of cancer cells,
- Viral and cellular oncogenes, Development of cancer
- Types of cancer, Types of carcinogens,
- Therapeutics of cancer

Paper 4B: Practical (II)

Paper Code: ZL202C

Total Marks: 40 (IA = 16 + ESE = 24) Credit = 02

1. Identification with reasons —*Branchiostoma*, *Ascidia*, *Petromyzon*, *Myxine*, *Scoliodon*, *Hippocampus*, *Channa*, *Rohu*, *Dipnoi*, *Hyla*, *Calotes*, *Naja*, *Columba*, *Chiroptera*, *Bandicota/Rattus*.
2. Dissection and display of digestive system, IXth & Xth cranial nerves of *Cirrhinusmrigala/Channa*
3. Study of gill arch, cycloid & ctenoid scales, hyoid & pecten of fowl.
4. Study of Mitotic cell division stages
5. Study of meiotic cell division stages (permanent slide).
6. Study of salivary gland chromosome from larva of *Drosophila*

2nd Year
Semester-III
Paper 5: GENETICS
Paper Code: ZL301

Total Marks: 100 (IA = 40 + ESE = 60) Credit = 04

Unit - I

- Mendelian Inheritance
- Gene interaction with reference to epistasis and non-epistasis (co-dominance and incomplete dominance)
- DNA as a genetic material with experimental evidence

Unit – II

- Concept of alleles, lethal alleles and multiple alleles (ABO Blood grouping)
- Linkage, crossing over and recombination, gene mapping (three-point test cross)
- Sex determination in *Drosophila* (Genic balance theory) and human; Barr body.

Unit - III

- Chromosomal abnormalities and different syndromes in human—: Turner's syndrome, Klinefelter's syndrome, Down syndrome, Cri-du-Chat syndrome
- Autosomal and Sex-linked inheritance: Autosomal- Albinism and Thalassemia.
- Sex linked inheritance— Colour blindness and Haemophilia

Unit - IV

- Mutation: Types of mutation, mutagens, induction and detection of sex chromosomal lethal mutation by ClB method
- Human genetic disorders: Phenylketonuria and Alkaptonuria (Phenylalanine pathway), Albinism (Tyrosine pathway), Sickle cell anaemia.
- Cytoplasmic inheritance

Paper 6A: DEVELOPMENTAL BIOLOGY

Paper Code: ZL302C

Total Marks: 60 (IA = 24 + ESE = 36) Credit = 02

Unit - I

- Gametogenesis
- Ultrastructure of spermatozoa and ova with special reference to mammal
- Fertilization

Unit - II

- Cleavage, types, cleavage in frog and chick
- Gastrulation in chick embryo
- Fate map

Unit - III

- Extra-embryonic membrane formation and function in chick embryo
- Embryonic induction,
- Organizer concept
- Formation of the eye in chick embryo

Unit - IV

- Placenta: types and function.
- Formation of the placenta in rabbit
- Concept of In-vitro fertilization, stem cells
- Amniocentesis

Paper 6B: PRACTICAL(III)

Paper Code: ZL302C

Total Marks: 40 (IA = 16 + ESE = 24) Credit = 02

- Pedigree analysis in human (charts)
- Karyotyping in human (charts)
- Identification (with reasons) of male and female *Drosophila* and their mutants (microphotographs)
- Identification of chick embryo with reason (during different incubation period): 16-18 hours, 21- 24 hours, 48hours,72 hours.

2nd Year

Semester-IV

Paper 7: ANIMAL PHYSIOLOGY

Paper Code: ZL401C

Total Marks: 100 (IA = 40 + ESE = 60) Credit = 04

Unit - I

- Extracellular and intracellular digestions
- Transport of oxygen and carbon dioxide in mammals (Bohr effect and Chloride shift)
- Thermoregulation in Ectotherms and Endotherms, role of the hypothalamus in temperature regulation with regard to Endotherms

Unit - II

- Concept of Isotonic, Hypotonic, and Hypertonic solution, Osmoregulation in fresh and marine water fishes
- Mechanism of nitrogen excretion in vertebrates
- Mechanism of urine formation in mammals and counter-current mechanism

Unit - III

- Structure of neurone
- Resting membrane potential, origin of action potential, and propagation through myelinated and non-myelinated nerves
- Types of synapse, synaptic transmission, and neuromuscular junction
- Role of neurotransmitter
- Chemical and molecular muscular contraction

Unit - IV

- Ketogenesis and its regulation, ketone body synthesis and utilization
- Catabolism of amino acids: Transamination and Deamination
- Urea-Ornithine cycle and its significance
- Animal energetics – concept of energy metabolism
- Measurements of metabolic rate – direct and indirect colourimetry
- Concept of RQ and its significance

Paper 8A: ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY

Paper Code: ZL402C

Total Marks: 60 (IA = 24 + ESE = 36) Credit = 02

Unit - I

- Introduction to the endocrine system and classification of glands
- Hormones and their functions in vertebrates with special reference to protection in fishes, amphibia and birds
- Hormones and their functions in invertebrates with special reference to metamorphosis in insects

Unit – II

Histological structure and functions of-

- Pituitary gland,
- Thyroid gland,
- Pancreas,
- Adrenal gland,
- Testis and ovary

Unit - III

Endocrine disorder in human with special reference to-

- Pituitary
- Thyroid glands
- Adrenal glands

Unit - IV

- Role of hormones in Reproduction
- Spermatogenesis, and oogenesis
- Menstrual cycle
- Oestrus cycle in rat

Paper 8B: PRACTICAL (IV)

Paper Code: ZL402C

Total Marks: 40 (IA = 16 + ESE = 24) Credit = 02

- Study of osmosis (using human blood /RBC).
- Study of Haemin crystal formation from human blood
- Study of salivary amylase activity using starch solution
- Identification of permanent slides with reasons of transverse section of mammalian Thyroid gland, Pancreas, Ovary and Testis.
- Identification of leukocyte and ABO blood grouping

3rd Year

Semester -5

EVOLUTIONARY BIOLOGY AND CHRONOBIOLOGY

Paper Code: ZL 501C

Total Marks: 100 (IA = 40 + ESE = 60) Credit -4

Unit I: Origin of Life, Fossils, and Geological Time

- Origin of Life: Concept of Hot dilute soup, Proteinoid, Microsphere, Coacervate, Protocell; Experimental evidence of abiotic synthesis of biomolecules (Miller & Urey Experiment).
- Geological Time Scale: Basic idea with major examples of fauna; Background extinction and Mass extinction.
- Fossils: Types, methods of fossilization, and age determination (Carbon dating and other techniques).
- Evolution of horse as an example of macroevolution.

(This unit gives the foundation of how life originated and how evolutionary history is traced.)

Unit II: Principles of Evolutionary Biology

- Neo-Darwinism (Synthetic Theory of Evolution).
- Genetic variation: Sources of variation in natural populations (mutation, recombination, migration, etc.).
- Types of Natural Selection: Stabilising, Directional, and Disruptive.
- Hardy-Weinberg Principle: Gene and genotype frequency; conditions and significance.
- Factors influencing Hardy-Weinberg equilibrium (mutation, migration, selection, genetic drift (Bottleneck phenomenon, Founder effect), non-random mating).

(This unit deals with modern evolutionary mechanisms and population genetics.)

Unit III: Speciation and Isolation Mechanisms

- Isolating mechanisms: Types and importance of reproductive isolation.
- Modes of Speciation: Allopatric, Sympatric, and Parapatric.
- Adaptive radiation with reference to placental mammals.
- Brief case studies/examples of speciation with reference to resource partitioning (e.g.– Darwin's finches, cichlid fishes).

(This unit helps to understand how new species arise and maintain distinct identities.)

Unit IV: Chronobiology and Ethology

- Origin and History of Ethology: Contributions of Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen.
- Concepts of proximate and ultimate behaviour.
- Basics of Animal Behaviour: Innate vs. Learned behaviour (characteristics, differences, classifications, examples).
- Animal Communication: Role of pheromones in territory marking, courtship, and mating; Concept of Allelochemicals: Allomone, Kairomone, Synomone, Apneumone
- Biological Rhythms: Circadian, Tidal, and Lunar rhythms.
- Concept of Biological clock and its regulation.

(This unit links evolution with behaviour and biological timing.)

3rd Year, Semester - 5

Paper — ZL 502C (Theory)

Adaptation and Zoogeography

Total Marks: 60 (IA = 24 + ESE = 36) Credit = 02

Unit I: Adaptations – General Concepts

- Concept of adaptation in animals: Pre-adaptation, Post-adaptation, Primary adaptation, secondary adaptation, Homology, Analogy.
- Convergent and divergent adaptations (with examples).
- Adaptive radiation in placental mammals with special reference to teeth and limbs.
- Significance of adaptations in evolution and survival.

(This unit introduces to adaptation concepts and evolutionary patterns.)

Unit II: Adaptive Features in Selected Animals

- Adaptive features of Camel (desert adaptation – morphological, anatomical, and physiological).
- Adaptive features of Whale (aquatic adaptation – streamlining, blubber, physiological mechanisms).
- Adaptive features of Pigeon (aerial adaptation – wings, hollow bones, respiratory efficiency).
- Comparative approach: desert, aquatic, and aerial adaptations.
- Adaptive features of Hoolock Gibbon, *Chameleo* (Arboreal adaptation- morphological, anatomical, physiological)

(Knowledge of concrete examples of adaptation in familiar animals)

Unit III: Adaptation in Colouration and Mimicry

- Colouration in animals: Cryptic (camouflage) and Warning (aposematic) colouration.
- Mimicry in animals:
 - Protective mimicry
 - Aggressive mimicry
 - Warning mimicry
 - Batesian and Müllerian mimicry (with examples).
- Ecological and evolutionary significance of colouration and mimicry.

(This unit connects adaptations with ecology and survival strategies.)

Unit IV: Zoogeography

- Zoogeography: Definition and importance with special reference to Continental Drift Theory.
- Discontinuous distribution of animals with examples.
- Wallace's Line and Weber's Line – significance in biogeography.
- Zoogeographical realms of the world:
 - Geographical boundaries
 - Climate characteristics
 - Major faunal composition of each realm (with examples).
- Brief note on the relevance of zoogeography in biodiversity and conservation.

(This unit gives a global picture and knowledge for applied zoology, biodiversity, and ecology.)

5th Sem PRACTICAL -1
Paper Code: ZL502C (Practical)
Total Marks: 40 (IA = 16 + ESE = 24) Credit = 02

- Problems from Hardy-Weinberg equilibrium (gene and Genotype frequency)
- Adaptive features: *Fasciola*, *Physalia*, *Hemidactylus*, *Exocoetus*, *Rhacophorus*/ *Hyla*, *Chameleo*, *Columba*, *Chiroptera*.
- Placement of faunal groups in respective Zoogeographical realms (map pointing)
- Study of Skull and limb bone of Class — Amphibia, Reptiles, Aves and Mammals

3rd Year, Semester-5

Paper - 503C

ECOLOGY

(100 Marks— IA = 40 + ESE = 60) Credit -4

Unit I: Ecological Foundations

- Concepts of Autecology and Synecology with examples
- Ecosystem: Definition, structure, and components.
- Levels of ecological organization, concept of organism, population, community, ecosystem, biome, biosphere
- Laws of limiting factors, Liebig's law of minimum, Shelford's law of tolerance, Ecotype, Ecad, Guilds
- Concepts of habitat and niche including types of niches.

(This unit provides the basic building blocks of ecology.)

Unit II: Ecosystem Structure and Function

- Food chain (Grazing, Detritus) and Food web, Top-down and Bottom-up control
- Ecological pyramids: Numbers, Biomass, Energy
- Energy flow in ecosystems, Lindeman's law, Law of Thermodynamics (First and Second), Ecological efficiencies
- Population Ecology:
 - Density, Natalty, Mortality, Age distribution, Dispersion, Dispersal
 - Survivorship curves.
 - Population growth curves (exponential and logistic).
 - r- and k-selection

(This unit explains how energy and populations function within ecosystems.)

Unit III: Community Ecology and Succession

- Community characteristics: species diversity, abundance, dominance, richness, Shannon-Wiener index, Simpson index
- Stratification in communities (forest and lake examples).
- Ecotone and edge effect.
- Ecological succession: types (primary, secondary, autogenic, allogenic) and examples

- Process of succession (Terrestrial, Aquatic) with examples, concept and types of Climax.

(This unit shifts from individual/population level to community-level processes.)

Unit IV: Applied Ecology and Conservation

- Biodiversity: types and levels.
- Biodiversity hotspots, Keystone species, Umbrella species, Flagship species with examples.
- Wildlife conservation strategies: in situ and ex situ.
- Protected areas with special reference to Tripura.
- Red Data Book, Indian Wildlife Protection Act & Schedules.
- Threats and conservation strategies for selected species:
 - Indian Tiger, Phayre's Leaf Monkey, Indian Bison, Green Imperial Pigeon.

(This unit links ecology to real-world conservation)

3rd Year, Semester - 5

Paper - ZL504C (Theory)

PARASITOLOGY & BASIC MICROBIOLOGY

60 Marks - (IA = 24 + ESE = 36) Credit 02

Unit I: Host–Parasite Relationships

- Concepts of parasitism (monogenic, digenic, parasitoidism, super-parasitism, multiple-parasitism, hyper-parasitism) with examples, host–parasite interactions.
- Helminthic parasites:
 - *Taenia* (tapeworm).
 - *Ascaris* (roundworm).
- General impact of parasites on hosts.

(This unit builds the foundation of parasitology.)

Unit II: Protozoan Parasites and Human Diseases

- Life cycle, pathogenicity, and prophylaxis of:
 - *Plasmodium* (Malaria)
 - *Entamoeba* (Amoebiasis)
 - *Giardia* (Giardiasis)
 - *Wuchereria* (Filariasis)
- Importance of prophylactic measures in public health.

(This unit covers medically important parasites relevant to students' daily life and healthcare.)

Unit III: Basics of Microbiology

- Basics of microbial cell structure (Virus, Bacteria, *Mycoplasma*, Yeast and Mould)
- Classification of microbes based on:
 - Oxygen requirement (aerobes, anaerobes).
 - pH tolerance.
 - Staining properties (Gram-positive, Gram-negative, acid-fast).
- Microbes in animal guts:
 - Collembola.
 - Earthworm.
 - Ruminants.

(This unit explains microbial diversity and ecological roles.)

Unit IV: Applied Microbiology

- Concepts of Prebiotic, Probiotic, and Symbiotic interactions.
- Beneficial roles of microbes in:
 - Human health (gut flora, probiotics).
 - Animal welfare.
 - Agriculture and biotechnology (if desired, can add simple examples like nitrogen fixation, fermentation).

(This unit links microbiology to applied aspects)

3rd Year, Semester - 5

Paper - ZL504C (Practical)

Total Marks: 40 (IA = 16 + ESE = 24) Credit = 02

- Estimation of population density (i) Quadrature method (ii) Capture recapture method
- Identification and ecological role of the following: *Collembola*, Mite, *Daphnia*, *Cyclops*, *Cypris*
(Slides)
- Isolation of bacteria by serial dilution method / Gram staining.
- Identification and observation of gut parasite of cockroach / fish/ fowl

Books (5th Semester)

Evolutionary Biology, Chronobiology, Adaptation & Zoogeography

1. Evolution – Douglas J. Futuyma (Sinauer Associates / Oxford University Press)
2. Evolutionary Biology – Scott Freeman & Jon C. Herron (Pearson publishers)
3. Evolution – M.K. Agarwal (S. Chand & Company – Publisher)
4. Zoogeography and Animal Distribution – Darlington P.J. (Foreign, Wiley)

Adaptation & Zoogeography

5. Zoogeography: The Geographical Distribution of Animals – Darlington, P.J. (Wiley Publication)
6. Animal Adaptation and Distribution – Allee, W.C. & Schmidt, K.P. (University of Chicago Press)
7. Ecology and Zoogeography – M.S. Mani (McGraw Hill / Today & Tomorrow's Printers) (Indian; Rastogi Publications).
8. Biogeography: An Ecological and Evolutionary Approach – C. Barry Cox, Peter D. Moore, & Richard J. Ladle. (Wiley-Blackwell publisher)

Ecology

9. Ecology: Concepts and Applications – Manuel C. Molles (McGraw Hill publications)
10. Fundamentals of Ecology – Eugene P. Odum & Gary W. Barrett (Brooks Cole / Cengage)
11. Ecology and Environmental Biology – P.D. Sharma (Rastogi Publications)

Parasitology & Microbiology

12. Parasitology: Protozoan and Helminthic Infections – K.D. Chatterjee (CBS Publishers)
13. Foundations of Parasitology – Gerald D. Schmidt & Larry S. Roberts (McGraw Hill publications)
14. Microbiology – Prescott, Harley & Klein) McGraw Hill publications)

**DETAILED COURSE CONTENT OF
ZOOLOGY – MINOR**

(SEMESTER – 1ST - SEMESTER – 5TH)

1st Year
Semester-I
Paper 1A: NON-CHORDATES AND ECONOMIC ZOOLOGY
Paper Code: ZL101M
Total Marks: 60 (IA = 24 + ESE = 36) Credit - 03

Non-Chordates

Unit - I

Contribution of National Scientists in Zoology—

Salim Ali, Vishwa Gopal Jhingran, Hiralal Chaudhuri, Gopal Ch Bhattacharya, Ramdeo Mishra, Hargobind Khorana, Lalji Singh, Radha D Kale, M K Chandra Sekheran, C. R. Narayan Rao, M. C. Dash, Valmik Thapar.

Phylum – Protozoa

- Classification up to class
- General Characteristics
- Locomotion in *Amoeba*

Phylum – Parazoa

- Classification up to class
- General characteristics
- Canal system of *Sycon*

Phylum – Metazoa

- Classification up to class
- General characteristics
- Trimorphism & metagenesis of *Obelia*

Unit - II

Phylum – Platyhelminthes

- Classification up to class
- General characteristics
- Life cycle of *Fasciola hepatica*

Phylum – Nematelminthes

- Classification up to class
- General characteristics
- Life cycle of *Ascaris*

Phylum – Annelida

- Classification up to class
- General characteristics
- Digestive system of Earthworm

Unit - III

Phylum – Arthropoda

- Classification up to class
- General characteristics
- Digestive system of *Periplaneta*

Phylum – Mollusca

- Classification up to class
- General characteristics
- Respiratory system in *Pila*

Phylum – Echinodermata

- Classification up to class
- General characteristics
- Water vascular system in *Asterias*

Phylum – Hemichordata

- Classification up to class
- General characteristics of Hemichordata

Unit – IV - ECONOMIC ZOOLOGY**Vermiculture & Vermicomposting**

- Principle of vermicomposting, different ecological categories of earthworm (Epigeic, Endogeic, Anesic), importance of vermicomposting, vermitechnology & management.

Sericulture

- Principle, different types of silk moth and their host plants, rearing methods, diseases of silk moth . Management with special reference to local varieties

Apiculture

- Principle, different types of honey bees, rearing methods, diseases of honey bees. Management with special reference to local varieties

Fresh water pisciculture

- Polyculture
- Induced breeding technology
- Fish seed transportation, fish diseases,
- Management

Poultry

- Types of breeds
- Methods of rearing
- Health, diseases and their management

Basics of Dairy farming and management.

Paper 1B: PRACTICAL - 1

Paper Code: ZL101M

Total Marks: 40 (IA = 16 + ESE = 24) Credit - 01

PRACTICAL – I

1. Identification, Systematic position, and Specimen Characters
Paramoecium, *Scypha*, *Obelia*, *Physalia*, *Taenia*, *Ascaris*, *Metaphire*, , *Hirudinaria*, *Periplaneta*, *Pila*, *Octopus*, *Asterias*,
2. Dissection and display of digestivesystems of *Periplaneta*
3. Mouth parts of *Periplaneta*
4. Spot identification and economic importance of— *Perionyx*, *Apis* sp, *Bombyx* and some major Carps (Rohu, Catla, Mrigal).

Semester-II
Paper 2A: CHORDATES AND CELL BIOLOGY
Paper Code: ZL201M
Total Marks: 60 (IA = 24 + ESE = 36) Credit - 03

Chordates

Unit - I

Protochordata

- General characteristics of Cephalochordata with special reference to ciliary mode of feeding in *Branchiostoma/Amphioxus*.
- General characteristics of Urochordata with special reference to retrogressive metamorphosis in *Ascidia*

Cyclostomata

- General characteristics of Cyclostomata
- Differences between *Petromyzon* and *Myxine*

Pisces

- General Characteristics of Chondrichthyes & Osteichthyes
- Accessory respiratory organs in fishes

Unit - II

Amphibia

- General characteristics and classification upto order
- Parental care in Amphibia

Reptilia

- General characteristics and classification upto order
- Differences between venomous and non-venomous snakes

Unit - III

Aves

- General characteristics and classification upto order
- Double mode of respiration

Mammals

- General characteristics and classification upto order
- Digestive system of ruminant and non-ruminant

Unit – IV - CELL BIOLOGY

1. Structure and function of—

- Plasma membrane
- Nucleus
- Mitochondria
- Golgi bodies
- Ribosomes
- Endoplasmic reticulum
- Lysosomes

2. Cell cycle and regulations

3. Cell divisions

4. Cancer cell and its characters

Paper 2B: PRACTICAL -II
Paper Code: ZL201M
Total Marks: 40 (IA = 16 + ESE = 24) Credit - 01

PRACTICAL – II

1. Identification, systematic position, and specimen characters —*Branchiostoma*, *Ascidia*, *Petromyzon*, *Scoliodon*, *Channa*, *Rohu*, *Hyla*, *Naja*, *Columba*, *Chiroptera*.
2. Dissection and display of digestive system *Cirrhinus mrigala/Channa sp.*
3. Study of Mitotic cell division stages
5. Study of meiotic cell division stages (permanent slide).

2nd Year
Semester-III
Paper 3A: GENETICS & DEVELOPMENTAL BIOLOGY
Paper Code: ZL301M
Total Marks: 60 (IA = 24 + ESE = 36) Credit - 03

Genetics

Unit - I

- Mendelian Inheritance
- Genetic Interaction
- DNA as a genetic material

Unit - II

- Concept of alleles and multiple alleles (ABO Blood grouping)
- Crossing over and recombination
- Sex determination in *Drosophila* (Genic balance theory) and human; Barr body.

Unit - III

- Chromosomal abnormalities and different syndromes in human - Turner's syndrome, Klinefelter's syndrome, Down syndrome
- Autosomal and Sex-linked inheritance: Autosomal- Albinism and Thalassemia.
- Sex-linked inheritance- Colour blindness and Haemophilia
- Mutation: Types of mutation, mutagens
- Cytoplasmic inheritance

Unit – IV-DEVELOPMENTAL BIOLOGY

- Gametogenesis and ultrastructure of spermatozoa and ova.
- Fertilization
- Cleavage and Gastrulation in chick embryo
- Extra-embryonic membrane formation and function in chick embryo
- Placenta: types and function.

Paper 3B: PRACTICAL - III
Paper Code: ZL201M
Total Marks: 40 (IA = 16 + ESE = 24) Credit - 01

- Karyotyping in human (charts)
- Identification (with reasons) of male and female *Drosophila* (microphotographs)
- Identification of chick embryo with reason (during different incubation period): 24 hours, 48hours,72 hours.

Semester-IV
Paper 4A: ANIMAL PHYSIOLOGY, ENDOCRINOLOGY, AND
REPRODUCTIVE BIOLOGY

Paper Code: ZL401M

Total Marks: 60 (IA = 24 + ESE = 36) Credit - 03

ANIMAL PHYSIOLOGY

Unit – I

- Extracellular and intracellular digestions
- Transport of oxygen and carbon dioxide in mammals (Bohr effect and Chloride shift)
- Concept of Isotonic, Hypotonic and Hypertonic solution, Osmoregulation in fresh and marine water fishes

Unit - II

- Mechanism of nitrogen excretion in vertebrates
- Mechanism of Urine formation in mammals
- Generation of action potential in neurone, Synapse and synaptic transmission

ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY

Unit - III

- Introduction to Endocrinology and Endocrine glands
- Histological structure and functions of:
 - Pituitary gland,
 - Thyroid gland,
 - Pancreas,
 - Adrenal gland,
 - Testis and ovary

Unit - IV

- Types of hormones and their functions in vertebrates
- Endocrine disorder in human with special reference to Pituitary and Thyroid glands
- Role of hormones in the regulation of — spermatogenesis, oogenesis
- Oestrus cycle in rat

Paper 4B: PRACTICAL - IV

Paper Code: ZL402M

Total Marks: 40 (IA = 16 + ESE = 24) Credit - 01

Practical – IV

- Study of Haemin crystal formation from human blood
- Study of salivary amylase activity using starch solution
- Identification of permanent slides with reasons of the transverse section of the mammalian Pituitary, Thyroid gland, Adrenal gland, Pancreas, Ovary, and Testis.

3RD Year
Semester - V
Paper 5A: EVOLUTIONARY BIOLOGY, ADAPTATION & ZOOGEOGRAPHY
Paper Code: ZL501M
Total Marks: 60 (IA = 24 + ESE = 36) Credit - 03

Unit I: Origin and Evidence of Evolution

- Origin of Life: Chemical basis, abiotic synthesis of biomolecules (Miller–Urey Experiment).
- Protocells or Coacervates.
- Evolution of horse as an example of macroevolution.

(Foundation unit – introduces how life began and how evolutionary evidence is traced.)

Unit II: Modern Evolutionary Theories

- Neo-Darwinism (Synthetic Theory of Evolution).
- Genetic variation: mutation, recombination, gene flow, genetic drift.
- Types of Natural Selection: Stabilising, Directional, and Disruptive.
- Adaptive radiation in Placental mammals with special reference to limbs.

(Focuses on mechanisms driving evolution at the genetic and population levels.)

Unit III: Speciation and Isolation Mechanisms

- Isolating mechanisms and importance of reproductive isolation.
- Modes of speciation: Sympatric, Allopatric, Parapatric.
- Adaptive radiation with special reference to limbs of placental mammals

(Explains how new species arise and the role of reproductive barriers.)

Unit IV: Adaptation and Zoogeography

- Adaptive features of Camel (desert), Whale (aquatic), and Pigeon (aerial) – morphological, anatomical, physiological.
- Colouration: Cryptic and Warning.
- Mimicry: Protective, Aggressive, and Warning (Batesian & Müllerian).
- Zoogeographical realms of the world – geographical boundaries, climate, and faunal composition.

(Applied part – connects evolution with adaptations, distribution, and survival.)

3rd Year – Semester V
Paper Code: ZL501M (Practical)
Total Marks: 40 (IA = 16 + ESE = 24) Credit - 01

- Adaptive features: *Fasciola*, *Physalia*, *Hemidactylus*, *Exocoetus*, tree frog, *Chameleon*, *Columba*, *Chiroptera*.
- Placement of faunal groups in respective Zoogeographical realms (map pointing)
- Study of Skull and limb bone of Class — Amphibia, Reptiles, Aves and Mammals

**DETAILED COURSE CONTENT OF
ZOOLOGY (INTERDISCIPLINARY)**

**Interdisciplinary Course
[FUNDAMENTAL ZOOLOGY]**

1st Year
Semester – I
Paper – 1 (Theory)
ZL101-ID: Animal Diversity
Marks: 100 (IA = 40 + ESE = 60)

Unit I (Non-chordates)

Protozoa, Porifera, Cnidaria, Helminths

Phylum characters of **Protozoa, Porifera, Cnidaria, Helminths**

- Locomotory organelles in Protozoa
- Canal system in Porifera
- Polymorphism and metagenesis in Obelia
- Adaptive features of *Ascaris* and *Fasciola*

Unit II (Non-chordates)

Annelida, Arthropoda, Mollusca, Echinodermata

Phylum characters of Annelida, Arthropoda, Mollusca, Echinodermata. -Digestive and Circulatory system in Cockroach

- Excretory system in Earthworm
- Torsion and Respiratory system in *Pila*

Larva and Water Vascular system in Echinodermata

Unit III (Chordates)

Hemichordates, Cephalochordates, Urochordates

- Basic chordate characters, characters of Hemichordates, Cephalochordates, Urochordates .
- Retrogressive metamorphosis in Ascidia

Unit IV (Chordates - Vertebrates)

Cyclostomes, Pisces, Amphibia, Reptilia, Aves, Mammalia

Class characters of Cyclostomes, Pisces, Amphibia, Reptilia, Aves, Mammalia.

- Differences between Petromyzon and Myxine
- Chondrichthyes and Osteichthyes

Accessory respiratory organs

- Heart of Amphibia and Reptiles
- Poisonous and Non-poisonous snakes
- Exoskeletal structure and Flight adaptation in Aves
- Adaptation in Chiroptera, Camel, and Whale

Books Recommended:

- Invertebrates – L.H. Hyman
- Biology of Animals Vol-I by Ganguly, Sinha & Adhikari, New Central Book Agency, Kolkata
- Modern Text Book of Zoology: Invertebrates by R.L. Kotpal, Rastogi Publications
- Invertebrate Zoology by E.L. Jordan & P.S. Verma, S. Chand & Company Ltd.
- Biology of Animals Vol-II by Ganguly, Sinha & Adhikari, New Central Book Agency, Kolkata
- Modern Text Book of Zoology: Vertebrates by R.L. Kotpal, Rastogi Publications
- Vertebrate Zoology by E.L. Jordan & P.S. Verma, S. Chand & Company Ltd.

Interdisciplinary Course (Fundamental Zoology)

Semester – III

Paper – 2 (Theory)

ZL301-ID: Applied Zoology

Marks: 100 (IA=40 + ESE= 60) Credit 03

Vermiculture & Vermicomposting

Principle of vermicomposting, different ecological categories of earthworm (Epigeic, Endogeic, Anesic), importance of vermicomposting, vermitechnology & management.

Sericulture

Principle, different types of silk moth and their host plants, rearing methods, diseases of silk moth. Management with special reference to local varieties

Apiculture

Principle, different types of honey bees, rearing methods, diseases of honey bees. Management with special reference to local varieties

Fresh water pisciculture

Polyculture

Induced breeding technology

Fish seed transportation, fish diseases,

Management

Poultry

Types of breeds

Methods of rearing

Health, diseases, and their management

Basics of Dairy farming and management

Books Recommended:

- Economic Zoology by Shukla and Upadhyay
- Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac Culture. By Jabde, P.V.,
- Applied Zoology by T.K.Banerjee, New Central Book Agency, Kolkata
- A Hand Book of Economic Zoology by J. Ahsan & bS.P.Sinha, S.Chand & Company Ltd.
- Kenchor Jeeban Baichitra O Kencho Prajukti by Priya Sankar Chaudhuri, Gyan Bichitra Prakashani, Agartala.
- Comprehensive Sericulture Vol. II: Silkworm Rearing and Silk Reeling by Ganga, G. Oxford and IBH, New Delhi. (2003)
- Elementary Applied Zoology by Debjyoti Chattopadhyay, Book Syndicate Pvt. Ltd.
- Livestock production management by Shastry and Thomas

Interdisciplinary Course (Fundamental Zoology)

Semester – IV

Paper – 3 (Theory)

ZL401-ID: Genetic Disorders and Pathogenic Diseases

Marks: 100 (IA=40 + ESE= 60) Credit 03

Genetic Disorders

Structure and function of chromosome

ABO Blood groups

Concept on –

Haemophilia, colour-blindness, albinism, thalassemia, sickle cell anaemia, Down's syndrome, Turner's syndrome, Klinefelter's syndrome

Pathogenic Disease

Concept of host and parasite

Life cycle and control measures of –

Plasmodium, *Entamoeba*, *Giardia*, Liver fluke, Tape worm, Round worm, and *Ascaris*

Books Recommended:

- Genetics by M. W. Strickberger, Pearson Education India Ltd.
- Principles of Genetics by E. J. Gardner, M. J. Simmons & D.P. Snustad, Wiley Publishers
- Principle of Genetics, B. D. Singh. Kalyani Publications
- Genetics by P. K. Gupta, Rastogi Publications, Meerut
- Genetics by Verma & Agarwal, S. Chand & Company Ltd.
- Parasitology by K.D. Chatterjee,
- Text Book of Medical Parasitology by P. Chakraborty, New Central Book Agency
- Paniker's Text Book of Medical Parasitology by Paniker, C.K.J., Ghosh, S. Jaypee, New Delhi.
- Medical Parasitology by Dey, N.C., Dey, T.K. and Dey Sinha M. New Central Book Agency, Kolkata (2010)



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UG - 6th Semester Syllabus

Zoology

Major

Semester – VI

BASICS OF SYSTEMATICS AND BIOSTATISTICS

Paper Code: ZL601C

Total Marks: 100 (IA = 40 + ESE = 60)

Credit: 04

UNIT – I: Fundamentals of Systematics and Taxonomy

- Systematics and Taxonomy:
 - Definition and scope of: nomenclature, classification, identification, taxonomy, systematics, cladistics, phenetics
 - Different types of taxonomy: alpha, beta, gamma
 - Classification: Evolutionary (Phylogenetic), Phenetic (Numerical), Cladistic, Molecular, Biochemical
 - Phenon, Taxon and Category
- Basic terminologies:
 - Subspecies, Super-species, Sibling species, Polytypic species, Ring species, Cline
- Species concept:
 - Typological species concept
 - Nominalistic species concept
 - Biological species concept
 - Evolutionary species concept

UNIT – II: Principles of Classification and Zoological Nomenclature

- Concept of classification:
 - Three Domain / Kingdom Concept – Carl Woese (1977)
 - Five Kingdom Classification – R.H. Whittaker (1969)
- International Code of Zoological Nomenclature (ICZN):
 - Objectives and importance
 - Rules of zoological nomenclature
 - Principle of Priority
 - Type concept (Holotype, Paratype, Allotype, Syntype)
- Binomial and Trinomial nomenclature
- Synonymy and Homonymy: definitions and examples

UNIT – III: Population, Sampling and Descriptive Biostatistics

- Population and Sampling:
 - Definition of population and sample
 - Methods of collection of data
 - Random and non-random sampling
- Data tabulation and classification
- Frequency distribution
- Graphical presentation of data:
 - Bar diagram
 - Histogram
 - Frequency polygon
 - Line graph
 - Pie chart

- Concept of Central Tendency with numerical problems:
 - Mean
 - Median
 - Mode

UNIT – IV: Probability, Dispersion and Statistical Inference

- Measures of Dispersion:
 - Range
 - Quartile deviation
 - Mean deviation
 - Standard deviation
 - Coefficient of variation
- Probability and distribution:
 - Elementary concept of probability
 - Addition law of probability
 - Multiplication law of probability
 - Numerical problems
- Sampling distribution and Standard Error
- Chi-square test:
 - Concept and application
 - Mendelian and Non-Mendelian ratios
- t-test:
 - Definition
 - Properties
 - Applications and numerical problems

Semester – VI

BIOCHEMISTRY

Paper Code: ZL602C (THEORY)

Total Marks: 60 (IA = 24 + ESE = 36)

Credit: 02

UNIT – I: Basic Concepts and Biomolecules

- Concept of pH and buffers
 - Definition of pH
 - Types of buffers
 - Biological applications of buffers
- Biomolecules:
 - Carbohydrates: classification and biological importance
 - Proteins: structure, classification and functions
 - Lipids: classification and functions
 - Nucleic acids: DNA and RNA– basic structure and functions

UNIT – II: Enzymes and Enzyme Kinetics

- Enzymes:
 - Definition and general properties

- Classification of enzymes
- Coenzymes and cofactors
- Isoenzymes
- Ribozymes
- Mechanism of enzyme action:
 - Lock and Key theory
 - Induced Fit theory
- Enzyme kinetics:
 - Michaelis-Menten concept
 - Relationship between K_m and V_{max}
 - Lineweaver-Burk plot

UNIT – III: Regulation of Enzyme Activity and Carbohydrate Metabolism

- Factors affecting the rate of enzyme-catalysed reactions:
 - Substrate concentration
 - Enzyme concentration
 - Temperature
 - pH
- Enzyme inhibition– Reversible (Competitive, Non-competitive, Un-competitive) and irreversible (Allosteric enzyme)
- Feedback inhibition
- Carbohydrate metabolism:
 - Glycolysis (steps and ATP generation)
 - Glycogenesis
 - Gluconeogenesis

UNIT – IV: Oxidative Metabolism and Lipid Metabolism

- Citric Acid Cycle (Krebs cycle):
 - Steps and significance
- Electron Transport Chain (ETC):
 - Components and mechanism
 - ATP generation (oxidative phosphorylation)
- Pentose Phosphate Pathway:
 - Steps and biological significance
- Lipid metabolism:
 - β -oxidation of saturated fatty acids

Paper Code: ZL602C (PRACTICAL)

Total Marks: 40 (IA = 16 + ESE = 24)

Credit: 02

- Problems on chi-square and t-test
- Graphical representation of data on Bar diagram, Histogram and Pie chart
- Qualitative identification of Carbohydrate (mono, di and polysaccharides), protein and lipid
- Quantitative estimation of glucose (titrimetric)

- Preparation of buffers and Estimation of pH (pH meter) of biological samples
- Effects of temperature and pH on salivary amylase activity

Semester – VI

MOLECULAR BIOLOGY

Paper Code: ZL603C

Total Marks: 100 (IA = 40 + ESE = 60)

Credit: 04

UNIT – I: Organization of Genetic Material and DNA Replication

- Concept of gene and gene organization in prokaryotes
- Concept of Cistron, Recon and Muton
- Structure and types of DNA (A DNA, B DNA, Z DNA, cDNA, I DNA)
- DNA replication:
 - Semi-conservative nature of DNA replication
 - Replication in prokaryotes: Enzymes and proteins involved, Mechanism (initiation, elongation and termination)

UNIT – II: Transcription, Translation and Gene Regulation

- Transcription in prokaryotes:
 - Promoters, RNA polymerases
 - Process of transcription
 - Post-transcriptional modifications: Capping, Poly adenylation, Splicing of RNA (Spliceosome-mediated splicing)
- Translation in prokaryotes:
 - Genetic code, Wobble hypothesis
 - Process of Translation
- Gene regulation in prokaryotes:
 - Lac operon
 - Tryptophan operon

UNIT – III: Recombinant DNA Technology (RDT)

- Recombinant DNA technology: definition and scope
- Basic principles of RDT:
 - Tools of RDT: Restriction enzyme, DNA ligase, Cloning vectors (Plasmid, Cosmid, BAC, YAC), Host cells
 - Process of RDT: Identification and isolation desired DNA, Cutting of DNA, Ligation, Transformation and construction of chimeric DNA, Selection of transformed cell, Cloning and expression, mRNA to cDNA synthesis
- Concept of “DNA Fingerprinting”

UNIT – IV: Molecular Basis of Cancer and Applications of RDT

- Genetic basis of cancer:
 - Proto-oncogenes and viral oncogenes
 - Transformation of proto-oncogene to oncogene

- Tumour suppressor genes:
 - Functional importance of p53 gene
- Applications of recombinant DNA technology:
 - Medical applications– Humulin, Human growth hormone
 - Agricultural application– Genetically modified crops
 - Industrial applications– Penicillin, Industrial enzymes
- Potential benefits and hazards of RDT
- Ethical and biosafety considerations related to human health, animal health and environment

Semester – VI

APPLIED ENTOMOLOGY AND PEST MANAGEMENT

Paper Code: ZL604C (THEORY)

Total Marks: 60 (IA = 24 + ESE = 36)

Credit: 02

UNIT – I: Insect Characteristic features, anatomy, Physiology and Pest Concept

- Salient features of important insect orders:
 - Coleoptera
 - Diptera
 - Lepidoptera
 - Blattodea
 - Hemiptera
 - Orthoptera
- Insect morphology and anatomy with special reference to:
 - Mouth parts and legs (types and functions)
 - Digestive system
 - Respiratory system (terrestrial insects)
- Concept of pest:
 - Definition of pest
 - Types of pests (major, minor, key and potential pests)

UNIT – II: Field Crop and Vegetable Pests

- Nature of damage, biology and control of major crop pests:
 - *Scirpophaga incertulas* (Yellow stem borer)– Paddy pest
 - *Helicoverpa armigera* (Heliothis)– Sugarcane pest
 - *Heliopeltis theivora* (Tea mosquito bug)– Tea pest
- Nature of damage, biology and control of vegetable and orchard pests:
 - *Aulacophora* sp.– Pumpkin pest
 - *Leucinodes arbonalis*– Brinjal pest
 - *Sternochetus mangiferae*– Mango stone weevil

UNIT – III: Storage Pests, Beneficial Insects and Pollination

- Nature of damage, biology and control of stored grain pests:
 - *Sitophilus* sp.
 - *Tribolium* sp.
 - *Rhyzopertha* sp.
 - *Trogoderma granarium*

- Nature of damage, biology and control of pest of pulse:
 - *Callosobruchus* sp.
- Pollinators:
 - Definition of pollination
 - Insect pollinating agents
 - Mode of pollination
 - Importance of pollinators in agriculture
- Lac culture:
 - Systematic position of lac insect
 - Life cycle
 - Economic importance
 - Pests and enemies of lac insects and their control

UNIT – IV: Pest Control Methods and Insecticides

- Methods of pest control:
 - Mechanical control
 - Chemical control
 - Biological control (Virus, Bacteria, Predator, Parasitoid, Nematode)
 - Integrated Pest Management (IPM)
- Insecticides:
 - Types and classification
 - Organophosphates– mode of action and examples
 - Organochlorines– mode of action and examples
 - Carbamates– mode of action and examples
 - Botanicals and biopesticides– examples and advantages
- Contact and systemic pesticides:
 - Application methods
 - Hazards of pesticides and safety measures

Paper Code: ZL604C (PRACTICAL)

Total Marks: 40 (IA = 16 + ESE = 24)

Credit: 02

- Identification and economic importance of: *Scirpophaga incertulas*, *Sitophilus* sp., *Tribolium* sp., *Callosobruchus* sp., Prawn, Rotifer, *Cyclops*, *Daphnia* (Specimens/ Slides/ Microphotographs)
- Field visit and submission of insect pests (at least five) with their scientific name, systematic position, place of collection, name of host plant or crop, date of collection
- Isolation and quantification of genomic DNA (flowchart)/ Blue and white colony selection method (photographs)
- Identification of cancer cell (photographs)

Reference Books

Paper 13: BASICS OF SYSTEMATICS AND BIOSTATISTICS (ZL601C)

Indian Authors

1. V.K. Agarwal & Usha Gupta – Animal Taxonomy
2. P.S. Verma & V.K. Agarwal – Biostatistics
3. S. C. Gupta & V. K. Kapoor – Fundamentals of Mathematical Statistics

Foreign Authors

1. Ernst Mayr – Principles of Systematic Zoology
2. R.R. Sokal & F.J. Rohlf – Biometry

BIOCHEMISTRY (Theory & Practical) – ZL602C

Indian Authors

1. U. Satyanarayana & U. Chakrapani – Biochemistry
2. A.C. Deb – Fundamentals of Biochemistry
3. Plummer (Indian edition widely used) – An Introduction to Practical Biochemistry

Foreign Authors

1. Lehninger, Nelson & Cox – Principles of Biochemistry
2. Voet & Voet – Biochemistry

MOLECULAR BIOLOGY – ZL603C

Indian Authors

1. P.K. Gupta – Molecular Biology
2. D. Dash & A. Kumar – Molecular Biology

Foreign Authors

1. Watson et al. – Molecular Biology of the Gene
2. Lodish et al. – Molecular Cell Biology

APPLIED ENTOMOLOGY & PEST MANAGEMENT – ZL604C (Theory & Practical)

Indian Authors

1. V.B. Awasthi – Introduction to General and Applied Entomology
2. K.P. Srivastava – A Textbook of Applied Entomology
3. David & Ramamurthy – Elements of Economic Entomology

Foreign Authors

1. Gullan & Cranston – The Insects: An Outline of Entomology
2. Pedigo & Rice – Entomology and Pest Management



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UG - 6th Semester Syllabus

Zoology

Minor

Semester – VI

ECOLOGY, PARASITOLOGY, MICROBIOLOGY, AND BASICS OF SYSTEMATICS

Paper Code: ZL601M (THEORY)

Total Marks: 60 (IA = 24 + ESE = 36)

Credit: 03

UNIT – I: Ecosystem and Population Ecology

- Ecosystem:
 - Definition and components
 - Food chain and food web
 - Ecological pyramids
 - Energy flow in ecosystems
- Population ecology:
 - Natality, Mortality, Density, Age distribution, Dispersion, Dispersal
 - Survivorship curves
 - Population growth curves
 - r- and k-selection strategies

UNIT – II: Applied Ecology and Wildlife Conservation

- Applied ecology and biodiversity:
 - Types and levels of biodiversity
 - Biodiversity hotspots
 - Keystone species, Umbrella species, Flagship species
- Wildlife conservation:
 - In situ and ex situ conservation
 - Concept of protected areas with special reference to Tripura
- Red Data Book
- Indian Wildlife (Protection) Act and schedules
- Threats and conservation strategies for:
 - Indian Tiger
 - Phayre's Leaf Monkey
 - Indian Bison
 - Green Imperial Pigeon

UNIT – III: Parasitology and Basic Microbiology

- Host-parasite interaction with reference to helminthic parasites:
 - *Taenia* (tapeworm)
 - *Ascaris* (roundworm)
 - *Fasciola* (flatworm)
- Life cycle, pathogenicity and prophylaxis of protozoan parasites:
 - *Plasmodium* (Malaria)
 - *Entamoeba* (Amoebiasis)
 - *Giardia* (Giardiasis)

- Microbes in animal gut with biological significance:
 - Cockroach
 - Collembola
 - Earthworm
 - Ruminants
- Concept of Prebiotic, Probiotic and Symbiotic interaction
- Role of microbes in human and animal welfare

UNIT – IV: Basics of Systematics and Taxonomy

- Systematics and Taxonomy:
 - Definition and scope of: nomenclature, classification, identification, taxonomy, systematics, cladistics
 - Different types of taxonomy: alpha, beta, gamma
 - Phylogenetic classification
 - Phenon, Taxon and Category
- Binomial and Trinomial nomenclature
- ICZN:
 - Rules of zoological nomenclature
 - Principle of priority
 - Synonymy and Homonymy
- Concept of classification:
 - Five-kingdom concept (Whittaker, 1969)
 - Linnaean hierarchy
- Species concepts:
 - Biological species concept
 - Evolutionary species concept

Paper ZL601M (PRACTICAL)

Total Marks: 40 (IA = 16 + ESE = 24)

Credit - 01

- Estimation of population density by Quadrate method.
- Identification and ecological importance of the following: *Collembola*, Mite, *Daphnia*, *Cyclops*, *Cypris* (Slides).
- Study of gut parasites of cockroach/ fish/ fowl.
- Identification of parasitic features – slides of *Plasmodium*, *Entamoeba* and *Giardia*.
- Filed report on visit to an Ecological park/ Wildlife Sanctuary .



NEP 2020

**UG – 7th & 8th Semester
Syllabus**

Zoology

Major

Semester— VII
Tools and Methods in Biology

Paper Code- ZL701C(THEORY)

Total Marks: 100(IA=40+ESE=60)

Credit- 04

Unit I: Microscopy and Centrifugation.

1. Microscopy (Principle, Construction, Working mechanism, Advantages and limitations, Applications in Biology) —

- Bright Field Microscopy
- Dark Field Microscopy
- Phase Contrast Microscopy
- Fluorescence Microscopy
- Transmission Electron Microscopy (TEM)
- Scanning Electron Microscopy (SEM)

2. Centrifugation

- Principle of centrifugation
- Relative Centrifugal Force (RCF)
- Types:
 - Differential centrifugation
 - Density gradient centrifugation
 - Ultracentrifugation
- Uses in biological research

Unit II: Spectrophotometry, pH Meter and Chromatography

1. Spectrophotometry

- Principle (Beer-Lambert Law)
- Instrumentation
- Types
- Applications

2. pH Meter

- Principle
- Components
- Working
- Calibration
- Applications

3. Chromatography

Principle of Chromatography

Types and applications

- Paper Chromatography
- Gel Filtration Chromatography
- Ion Exchange Chromatography
- Affinity Chromatography

Unit III: Electrophoresis and X-Ray Diffraction

1. Electrophoresis Principle

Types and applications

- Agarose Gel Electrophoresis
- Polyacrylamide Gel Electrophoresis (PAGE)

2. X-Ray Diffraction

Principle (Bragg's Law) and Uses in Biology

(Structure determination of proteins, DNA structure analysis, Crystallography)

Unit IV: Micro techniques

1. Principle of Microtome

- Purpose
- Types of microtomes

2. Fixatives and Fixation

- Principle of fixation
- Types of fixatives
 - Simple fixatives
 - Compound fixatives

3. Dehydration

- Principle
- Procedure

4. Embedding of Tissue

- Principle
- Procedure

5. Block Making

- Procedure and importance

6. Stains and Staining

- Principle of staining
- Types of stains
 - Acidic
 - Basic
 - Neutral
 - Vital stains

7. Double Staining

- Principle
- Procedure
- Applications

**Semester – VII
(Biophysics)**

Paper Code: ZL702C (THEORY)

Total Marks: 60(IA=24+ESE=36)

Credit- 02

Unit I: Thermodynamics in Biology

1. Concept of Free Energy (Gibbs Free Energy)
2. Enthalpy (H)
3. Entropy (S)
4. Laws of Thermodynamics
 - First Law
 - Second Law
 - Third Law
5. Significance of Thermodynamics in Biology

Unit II: Colloids and Crystalloids

1. Definition of Colloids and Crystalloids
2. Properties of Colloids
 - Brownian movement
 - Tyndall effect
 - Adsorption
 - Diffusion
3. Properties of Crystalloids
4. Differences between Colloids and Crystalloids
5. Biological Importance

Unit III: Membrane Biophysics

1. Biophysical Nature of Cell Membrane
 - Fluid Mosaic Model
 - Membrane composition
2. Ion Channels
 - Sodium channels
 - Potassium channels
 - Calcium channels
3. Membrane Transport
 - Passive transport
 - Facilitated diffusion
 - Active transport

Unit IV: Bioenergetics and ATP Synthesis

Topics

1. Definition of bioenergetics; energy transformations in living cells, ATP as the universal energy currency.
2. Proton Motive Force (PMF) - Definition, components of PMF(Proton H^+ gradient ΔpH , membrane potential $\Delta \Psi$), generation of PMF during electron transport, Biological significance.
3. Chemiosmotic theory – Introduction, Peter Mitchell's chemiosmotic theory, Electron transport chain and proton pumping. Role of PMF in ATP synthesis. Importance and evidence supporting the theory.
4. ATP Synthase- Structure; F_o and F_1 components, rotary catalytic mechanism, function in ATP synthesis.
5. ATP transport and synthesis- Oxidative phosphorylation, movement of ADP and ATP across the mitochondrial membrane, phosphate transport, ATP production mechanism.
6. Couplers of ATP Synthesis- Definition, components that enable ATP synthesis by coupling electron transport to phosphorylation.
7. Uncouplers of ATP Synthesis- Definition, effects on oxidative phosphorylation, examples of Uncouplers (2,4, dinitrophenol; thermogenin).

Semester – VII (Biophysics)

Paper Code: ZL702C (Practical)

Total Marks: 40 (IA-16+ESE-24)

Credit- 02

- Double staining and identification of histological slides - Mammalian Liver, Testis, Kidney, Pancreas, Thyroid.
- Paper chromatography (from leaf extract / amino acid)
- Studies of simple and compound microscope — Principle, Name of parts and function from picture (photograph)
- Studies of microtome — Principle, identification of parts and functions.
- Study of passive transport using resin
- Study on centrifuge apparatus.
- Plankton isolation using centrifuge apparatus.

Semester - VII
Microbiology and Immunology
Paper Code: ZL703C
Total Marks : 100 (IA 40 + ESE 60)
Credit: 04

Unit I: History of Microbiology, Microbial Growth and Cultivation

1. Brief History of Microbiology

- Germ Theory of Disease
- Antonie van Leeuwenhoek
- Louis Pasteur
- Robert Koch
- Alexander Fleming
- Anandamohan Chakrabarty

2. Nutrition and Bacterial Growth

- Autotrophs and Heterotrophs
- Growth requirements:
 - pH
 - Oxygen
 - Temperature
- Bacterial growth curve:
 - Lag phase
 - Log phase
 - Stationary phase
 - Death phase

3. Cultivation of Microorganisms

- Serial dilution method
- Culture media and types
- Pour plate technique
- Streak plate technique
- Spread plate technique

Unit II: Sterilization and Microbes in Health & Diseases

1. Sterilization

Physical Methods

- Hot Air Oven
- Autoclave
- Laminar Air Flow, Ionizing Radiation (X-Ray and Gamma Ray), Non-Ionizing Radiation (U.V light)

Chemical Methods

- Phenols
- Alcohols
- Organic disinfectants
- Hydrogen peroxide

2. Role of Microbes in Human and Animal Health

Bacterial Diseases

- Shigellosis
- Salmonellosis

Rickettsial Diseases

- Spotted Fever
- Typhus Fever

Viral Diseases

- Severe Acute Respiratory Syndrome (SARS)

Fungal Diseases

- Ringworm
- Candidiasis

3. Normal Microbial Flora and their importance

- Skin flora
- Gut flora
- Urogenital Tract
- Oral and upper respiratory tract

4. Antibiotics

- Definition
- Types and mechanism of action — Cell wall synthesis inhibitors, Protein synthesis inhibitors, nucleic acid synthesis inhibitors.

5. Vaccines and Antisera

- Concepts of vaccine
- Types of vaccines : Subunit and DNA vaccines — Characteristics, advantages and disadvantages.
- Anti sera — Anti-venom. Antitoxin, toxoids and their uses

Unit III: Basics of Immunology

- 1. Introduction to Immunology**
- 2. Cells and Organs of Immune System**

Cells — characteristics and mode of function of —

- B lymphocytes
- T lymphocytes
- Macrophages
- NK cells
- Neutrophils
- Eosinophils
- Mast cell

Organs— Characteristics and mode of action of —

- Bone marrow
- Thymus
- Spleen
- Lymph nodes

- 3. Cell-Mediated and Humoral Immunity— effectors imparting immunity, complement system, cytotoxin/chemokine, Antibodies, B-cell and T-cell epitopes.**

4. Antigenicity and Immunogenicity—

- Definition of antigen.
- Immunogenicity— Definition, Characteristics of Immunogenicity
- Importance of immune responses in disease protection.
- Difference between antigenicity and immunogenicity.
- Antigenicity—Definition, Characteristics of Antigenicity.

5. Factors Influencing Immunogenicity—

- Foreignness
- Molecular size
- Chemical complexity
- Degradability by antigen-presenting cells
- Route of administration
- Dose of antigen
- Host factors (age, genetics, health)

Unit IV: Antibodies, MHC, Complement and Vaccination

1. Immunoglobulins

- Structure of antibodies and their types
- Classes:
 - IgG
 - IgA
 - IgM
 - IgE
 - IgD

2. Antigen–Antibody Interactions

- Agglutination
- Precipitation
- Neutralization

3. Immunoassays

- ELISA
- RIA (basic concept)

4. Monoclonal Antibodies

- Hybridoma Technology
- Applications

5. MHC Molecules

- MHC Class I
- MHC Class II
- Functions

6. Hypersensitivity Reactions

- Type I - Immediate
- Type II - Cytotoxic
- Type III - Immune complex mediated
- Type IV - Delayed (Cell mediated)

Semester - VII

MEDICAL ZOOLOGY

Paper Code : ZL704C (THEORY)

Total Marks : 60 (IA 24 + ESE 36)

Credit: 02

Unit I: Blood & Tissue Protozoa

1. *Plasmodium vivax*, *Plasmodium falciparum*, *Plasmodium ovale*, *Plasmodium malariae*— life cycle, pathogenicity, control measures, Comparisons between four distinct species of *Plasmodium*.
2. *Leishmania donovani* (Kala-azar / Visceral Leishmaniasis)— Life cycle, pathogenicity, control measures.
3. *Trypanosome*(Trypanosomiasis / Sleeping sickness)—life cycle, pathogenicity, control measures.
4. Concept of reservoir host, monogenic parasite , digenic parasite.

Unit II: Intestinal & Luminal Parasites

Life cycle, pathogenicity, preventive measures of —

- A. *Balantidium coli*
- B. *Echinococcus granulosus* (Hydatid Worm)
- C. *Ancylostoma duodenale* (Hookworm)

Unit III: Filarial Parasites & Major Dipteran Vectors

- A. *Wuchereria bancrofti* (Filarial Worm)— life cycle, pathogenicity, control measures
- B. Mosquitoes (*Anopheles*, *Culex*, *Aedes*) — life cycle, pathogenicity, control measures
- C. Tsetse Flies (*Glossina*) — life cycle, pathogenicity, control measures
- D. House Fly (*Musca domestica*) — life cycle, pathogenicity, control measures

Unit IV: Ectoparasites - diseases, role as vector, symptoms and control measures of —

- A. Lice (*Pediculus*): Pediculosis (itching); Epidemic Typhus and Relapsing Fever.
- B. Bedbug (*Cimex*): Papular urticaria (allergy).
- C. Fleas (*Xenopsylla*): Bubonic Plague (*Yersinia pestis*) and Murine Typhus.
- D. Mites:
 - Sarcoptes (Itch mite): Scabies.
 - Eutrombicula (Chiggers): intense dermatitis (Trombiculiasis).
- E. Ticks (Comparison):
 - Hard Tick (Dermacentor): Rocky Mountain Spotted Fever.
 - Soft Tick (Argas): Relapsing Fever.

Semester - VII

MEDICAL ZOOLOGY

Paper Code : ZL704C (PRACTICAL)

Total Marks : 40 (IA 16 + ESE 24)

Credit: 02

1. **Sterilization Methods** — Principle, demonstration using a hot air oven, water bath, Use of chemicals such as alcohol, acetone, and different acids — for sterilization of laboratory glass goods.
2. Simple staining (Crystal Violet) and gram staining (Primary Crystal Violet, Counter stain — Staining using curd as a source of Bacteria)
3. Study of MBC (Microbial Biomass Carbon) of soil using respirometric technique
4. **Identification of Parasites and Vectors—**

Identify the following organisms with their characteristic features and the diseases they cause:

- | | |
|--------------------------|--------------------------|
| · <i>Leishmania</i> sp. | · <i>Plasmodium</i> sp. |
| · <i>Trypanosoma</i> sp. | · <i>Balantidium</i> sp. |
| · <i>Ancylostoma</i> sp. | · <i>Culex</i> sp. |
| · <i>Aedes</i> sp. | · <i>Anopheles</i> sp. |
| · <i>Musca</i> sp. | · <i>Pediculus</i> sp. |
| · <i>Cimex</i> sp. | |

Semester— VIII
Global Environmental Issues biodiversity and conservation
Paper Code- ZL801C (THEORY)
Total Marks: 100 (IA=40+ESE=60)
Credit- 04

Unit 1: Environmental Pollution and ecotoxicology

- **Air, Water, Soil and Sound pollution– sources and effects**

Air Pollution: Sources (Industrial emissions, vehicular exhaust, burning of fossil fuels, agricultural burning), AQI (Air Quality Index); Kinds (Primary– CO, SO₂, NO_x, particulate matter and Secondary– Ozone, PAN - formed by reactions), effects (Respiratory diseases– COPD, asthma), smog, photochemical smog, damage to vegetation, and corrosion of buildings.

Acid Rain: Causes (emission of SO₂ and NO_x), effects on Humans (Respiratory irritation), effects on ecosystem (Leaching of soil nutrients– Ca, Mg, acidification of lakes– death of fish) and forest dieback (damage to leaf cuticles).

Water Pollution: Sources (Industrial effluent– heavy metals), agricultural runoff (pesticides, fertilizers), sewage discharge; Kinds (Biological– pathogens, Chemical– eutrophication and Physical– thermal pollution); Effects (cholera, typhoid, biomagnification, and collapse of aquatic ecosystem).

Soil Pollution: Sources and causes of soil pollution, types of soil pollutants, effects on soil quality, flora, fauna, and human health. Bioaccumulation and biomagnification of soil contaminants, soil conservation and remediation techniques (bioremediation and phytoremediation), prevention and control measures. Management of biomedical waste, plastic waste, and E-waste.

Sound (Noise) Pollution: Sources (traffic, industrial machinery, construction, loudspeakers) and effects (hearing loss, hypertension, sleep disturbances and stress-induced cardiovascular issues)

- **Ecotoxicology of heavy metals and pesticides related to soil and water pollution:** case studies on As, Pb, Cd and Hg toxicity, organophosphates and organochlorides; asbestosis; toxicants as carcinogens; physiological defence mechanisms (HSPs, metallothionins, phytochelatins).

Unit 2: Global Atmospheric Crises

- Stratospheric and tropospheric changes, international protocols, and climate impact; Ozone Depletion– its causes and effects; Mitigation and Protocols– Vienna Protocol, Montreal Protocol, Kigali Amendment.
- **Global Warming and Greenhouse Effect (effect on agriculture, economy and human health)**
- **Climate Change Trends and Protocols:** Trends (Rising global average temperature, melting polar ice caps, sea-level rise, increased frequency of cyclones/droughts), International Agreements (Kyoto Protocol, Paris Agreement)

Unit 3: Biodiversity Patterns and Estimation

- **Biodiversity Patterns:** Species richness and evenness in relation to Latitude and Elevation
- **Biodiversity Estimation Methods:** Qualitative (Scoring, Habitat assessment), Quantitative– Richness, Density, Abundance, Diversity indices (Shannon-Weiner, Simpson).
- **Community Diversity (Whittaker's concept):** Alpha (α), Beta (β), Gamma (γ) diversity
- **Molecular Techniques for Biodiversity:** RAPD, RFLP
- **Importance of Biodiversity:** Ecological (Nutrient cycling, pollination, climate regulation), Economic (Food, medicine, raw materials), Ethical/Aesthetic (Cultural value, intrinsic right to exist).

Unit 4: Threats to biodiversity and Conservation Strategies (Indian Context)

- **Threats to Biodiversity:** Natural (Earthquakes, floods, volcanic eruptions, forest fires), Anthropogenic (habitat loss and deforestation, hydropower dams), Hunting/poaching, Over-exploitation of resources, and Man-Wildlife Conflict (crop raiding, livestock depredation leading to retaliation).
- **Biodiversity in India:** Biodiversity hotspot, global and Indian context, National Biodiversity Action Plan (NBAP)
- **Conservation Strategies:** In-situ and Ex-situ conservation
- **Policy and Management Tools:** IUCN Red List, Categories, Red and Green Data Book, Eco-restoration, Joint Forest Management (JFM)

Semester— VIII
Research Methodology, Animal Ethics and IPR
Paper Code- ZL802C (THEORY)
Total Marks: 60 (IA=24+ESE=36)
Credit- 02

Unit 1: Fundamentals of Research and Literature Review

- Types of Research: Basic and Applied, Descriptive and Analytical, Quantitative and Qualitative
- Research Methods vs. Methodology: Methods (specific tools/techniques– PCR, ELISA, surveys), Methodology (philosophical framework and rationale behind choosing those methods)
- Literature Review: Purpose (to identify gaps, avoid duplication, and frame hypotheses), Consolidation (Summarizing, synthesizing, and critically evaluating existing literatures)
- Research Environments: Library Research, Field Research, Laboratory Research

Unit 2: Data Collection, Documentation and Biological Models

- Data Collection and Documentation (Laboratory notebook, Tabulation, Graphs, Scattered plots)
- Overview of Biological Problems and Model Organisms: *Drosophila melanogaster*, *Escherichia coli*, *Rattus norvegicus*, *Oryctolagus cuniculus*, *Cavia* sp., *Saccharomyces* sp., *Mus musculus*

Unit 3: Scientific Writing, Ethics, and Animal Welfare (3Rs & Principles)

- The Art of Scientific writing and Presentation: Numbers and Units: Use SI units, Abbreviations and Nomenclature.
- Writing References: Common styles– APA, MLA, or most commonly Vancouver or Harvard in biological sciences. Use of citation managers (e.g., EndNote, Zotero)
- Scientific Ethics and Plagiarism: rules related to ethics and plagiarism
- Animal Ethics (The Core Principles):
With respect to Animals' Dignity, Principle of proportionality
- The "3Rs" Framework: Replace, reduce and refine

Unit 4: Intellectual Property Rights (IPR) – Types and Significance

- Basic Knowledge of the 4 Types of IPR: Trademarks, Copyrights, Patents and Trade Secrets
- Geographical indications (GI)
- Infringement and licencing

Paper Code- ZL802C (PRACTICAL)

Total Marks: 40 (IA=16+ESE=24)

Credit- 02

1. Detection of SPM from air in different areas using Air Impringement Technology.
2. Determination of dissolved carbon di oxide in water bodies by titration method.
3. Determination of soil pH from paddy field and pastures.
4. Comment on the IUCN status of the fauna (photographs/chart)
5. Identification of common GI tags.
6. Study of Microbial Biomass carbon (MBC) through soil respirometric technique.
7. Visit to a Wildlife Sanctuary and submission of a field report.

Semester— VIII
Aquaculture
Paper Code- ZL803C (THEORY)
Total Marks: 100 (IA=40+ESE=60)
Credit- 04

Unit 1: Fundamentals of Aquaculture and Aquatic Ecosystems

- **Aquaculture: Principles and Practices:** Principles (Stocking density, species selection, feed management, disease control, and water quality maintenance), Practices (Extensive system– low-input, natural ponds, Semi-intensive system– supplementary feeding, and Intensive system– high-density, complete feed, aeration)
- **Kinds of Aquatic Ecosystems:** Lentic– Wetland (swamps, marshes, bogs, fens), Pond, Lake; Lotic– River, Estuary

Unit 2: Types of Aquaculture and Species Selection

- **Types of Aquacultures (Culture Systems):** Carp Culture: Polyculture of Indian Major Carps and Exotic Carps; Air-breathing Fish Culture: *Clarias* sp., *Heteropneustes* sp, *Anabas* sp; Prawn Culture: freshwater (*Macrobrachium rosenbergii*), brackish water (*Penaeus monodon*); Pearl Culture: *Pinctada* sp.

Unit 3: Captive Breeding, Genetics, and Nutrition

- **Captive Breeding Technology:** Broodstock management, induced breeding (hormone therapy, synthetic hormones), egg collection and incubation
- **Supplementary Diets and its Composition:** Purpose, Composition of a balanced diet (proximate composition); Types: Floating pellets, Sinking pellets; Formulated fish feed

Unit 4: Water Quality Monitoring and Farm Management

- **Water Quality Monitoring in Captive Breeding Farms:** Dissolved Oxygen (DO), Temperature, pH, Ammonia (NH₃), Nitrite (NO₂⁻), Alkalinity/Hardness, Turbidity; aquatic bioindicators (macroinvertebrates, algae, phytoplankton, fish and macrophytes).
- **Farm management:** stock and health monitoring with special reference to fish diseases
- **Monitoring tools and equipments:** Digital probes/ meters, colorimetric test kits, Secchi disk

Semester— VIII
Computational Biology and Biotechnology
Paper Code- ZL804C (THEORY)
Total Marks: 100 (IA=40+ESE=60)
Credit- 04

Unit 1: Fundamentals of Computational Biology and Bioinformatics

- **Applications:** Genomics– Genome assembly, annotation, and comparative genomics (identifying SNPs), Proteomics– Biomodelling/Biomolecular Designing (Computer-aided drug design (CADD), molecular docking, and simulation of protein-ligand interactions.
- **Evolutionary Biology:** Phylogenetic tree construction to study species divergence and molecular evolution, Database Management and Bioinformatics Resources– Nucleic Acid Sequence Databases, Genome Databases
- **Biodiversity and Ecosystem Databases:** GBIF (Global Biodiversity Information Facility), FishBase, and NCBI Taxonomy

Unit 2: Data Retrieval, Sequence Analysis and Tools

- **Introduction to Data Retrieval Systems:** Search Engines (Google Scholar, PubMed, NCBI), Sequence Retrieval System (SRS), Protein Identification Resource (PIR)
- **Molecular Sequence Analysis Software and Tools:** Prediction of Motifs (PROSITE, MEME), Folds and Domains (Phyre2, I-TASSER), Sequence Alignments (BLAST, Clustal W), Phylogenetic trees (MEGA, PhyML), NCBI– GenBank, PubMed

Unit 3: Core Molecular Biology Techniques

- **Biotechnology:** Concept and Scopes
- **Cloning Vectors**
- **Restriction Enzymes:** Nomenclature, mechanism of action
Construction of Genomic and cDNA Libraries, Southern blot, Northern blot, and Western Blot
- **DNA Sequencing:** Sanger method, Next-Generation
- **genome-editing technology:** CRISPR-Cas system

Unit 4: Advanced Techniques, Transgenics and Medical rDNA Applications

- **Production of Cloned and Transgenic Animals:** Cloned Animals, Transgenic Animals, process of cloning and transgenesis in animals
- **Use of Recombinant DNA Technology in Medicine:** Humulin, HGH, Hybridoma technology
- **General Importance**

Paper Code- ZL804C (PRACTICAL)

Total Marks: 40 (IA=16+ESE=24)

Credit- 02

1. Project

- a. Review of Literature
- b. Field Work / Data collection
- c. Computation and Analysis of Result
- d. Report Submission and Presentation



NEP 2020

**UG – 7th & 8th Semester
Syllabus**

Zoology

Minor

Semester-VII
Applied Entomology and Aquaculture
Paper Code: ZL701M (Theory)
Total Marks: 60 (IA-24 + ESE-36)
Credit-03

Unit I: Insect Morphology and Anatomy

1: Introduction to Applied Entomology

- Scope and importance of applied entomology
- Economic importance of insects

2: External Morphology of Insects

- Body regions (Head, Thorax, Abdomen)
- Types of antennae, wings and legs
- Mouthparts of Butterfly, Housefly and Honeybee

3: Internal Anatomy of Insects

- Digestive system
- Respiratory system
- Comparative study of Butterfly, Housefly and Honeybee

Unit II: Agricultural and Stored Grain Pests

1: Crop Pests

- Biology, nature of damage and control of:
 - *Scirpophaga incertulas* (Paddy pest)
 - *Helicoverpa armigera* (Major crop pest)
 - *Leucinodes orbonalis* (Brinjal pest)
 - *Sternonchetus mangiferae* (Mango weevil)

2: Stored Grain Pests

- Biology, nature of damage and control of:
 - *Sitophilus* sp
 - *Tribolium* sp
 - *Rhyzopertha* sp
 - *Trogoderma granarium*

Unit III: Beneficial Insects and Lac Culture

1; Pollinators

- Definition
- Insect pollinating agents
- Mechanism (mode) of pollination
- Importance of pollinators in agriculture and ecosystems

2: Lac Culture

- Systematic position
- Life cycle
- Economic importance
- Pests and natural enemies

- Control measure

Unit IV: Aquaculture

1: Introduction to Aquaculture

- Principles and practices of aquaculture

2: Types of Aquacultures

- Carp culture
- Prawn culture
- Selection of species for aquaculture

3: Hatchery and Farm Management

- Captive breeding technology
- Supplementary feeds and feed composition
- Water quality monitoring and management in captive breeding farms

Semester-VII Applied Entomology and Aquaculture

Paper Code:ZL701M (Practical)

Total Marks: 40 (IA-16 + ESE-24)

Credit-01

- Identification and economic importance of – *Scirpophaga incertulus* (Paddy pest), *Sitophilus* sp, *Tribolium* sp, Prawns, *Rotifer*, *Cyclops*, *Daphnia*, *Macrobrachium* (Specimens/Slides/Microphotographs)
- Estimation of dissolved oxygen from water by Winkler's Method
- Analysis of pH of pond water
- Submission of insect pests (at least five numbers) with their Scientific name, Order, Place of collection, name of the host plant, date of collection

Semester-VIII
Biochemistry, Molecular Biology, Immunology and Biostatistics
Paper Code: ZL801M (Theory)
Total Marks: 60 (IA-24 + ESE-36)
Credit-03

Unit I: Biochemistry

1: Biological Buffers, concept of pH and their biological applications

2: Biomolecules— Structure, functions

- Carbohydrates
- Proteins
- Lipids
- Nucleic acids

3: Enzymes

- General properties (Enzyme action, Factor affecting enzyme action).
- Coenzymes
- Isoenzymes
- Ribozymes

4: Cellular Respiration

- Glycolysis
- Krebs Cycle
- Electron Transport Chain (ETC)
- ATP generation of glycolysis, Krebs' cycle, ETC.

Unit II: Molecular Biology

1. DNA Replication (Prokaryotes)

2. Transcription (Prokaryotes)

3. Translation (Prokaryotes)

4: Gene Structure. Concept of Cistron, Recon, Muton

5. Gene Regulation— Lac Operon and related problems.

6. Molecular Basis of Cancer—Proto-oncogenes, Viral oncogenes, Transformation of proto-oncogene to oncogene

7. Recombinant DNA Technology—Potential benefits, Hazards and Applications (Brief)

Unit III: Immunology

1: Introduction to Immunology—Cells and organs of immune system

2: Types of Immunity— Cell-mediated immunity, Humoral immunity

3: Antigens and Immunogens

- Antigenicity and Immunogenicity
- Immunogens
- Adjuvants
- Haptens
- Factors influencing immunogenicity
- B-cell and T-cell epitopes

4: Immunoglobulins- Structure, Classes, Functions

5: Antigen–Antibody Interaction— Types, Biological significance

Unit IV: Biostatistics

1: Introduction to Biostatistics—Definition, Importance in biological research

2: Data Presentation—Types of data, Frequency distribution, Tabulation

3: Graphical Representation of Data

- Bar diagram
- Histogram
- Frequency polygon
- Pie chart
- Line graph

4: Statistical Tests

- Chi-square (χ^2) test
 - Principle
 - Applications and related problems
- Student's t-test
 - Principle
 - Applications and related problems

Semester-VIII

Biochemistry, Molecular Biology, Immunology and Biostatistics

Paper Code: ZL801M (Practical)

Total Marks: 40 (IA-16 + ESE-24)

Credit-01

1. Qualitative identification of carbohydrates (mono-, di-, and polysaccharides)
2. Qualitative identification of proteins
3. Qualitative identification of lipids
4. Quantitative estimation of glucose (titrimetric method)
5. Identification of different leukocytes from prepared blood smear
6. Determination of ABO Blood Group
7. Preparation and graphical representation of biological data using:
 - Bar graph
 - Histogram
 - Pie chart
 - Line graph
8. Calculation and interpretation of:
 - Chi-square (χ^2) test
 - Student's t-test (simple problems)